LEARNING TO TEACH MATHEMATICS FOR SOCIAL JUSTICE: HELPING PRESERVICE TEACHERS CONNECT CRITICAL TOPICS TO STANDARDS

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This study examines how preservice teachers select standards, plan tasks, and develop a full lesson plan focused on a social justice context. While traditional studies of this topic involve scholars examining completed lesson plans, this study is unique in that audio data was recorded to capture the types of discussions preservice teachers engaged in while completing social justice lesson plans. Findings indicated that PSTs used keywords to map standards onto elements of the social justice context, that they vacillated between selecting a standard and developing an appropriate task, and that they treated the social justice context as a fixed scenario. I will share examples along with implications for how mathematics teacher educators can better support PSTs as they navigate this complex process.

Keywords: Equity, Diversity, Instructional activities and practices, Teacher knowledge

Introduction

Teaching mathematics for social justice (TMfSJ) is a complex process that involves the coordination of "fair and equitable teaching practices, high expectations for all students, access to rich, rigorous, and relevant mathematics, and strong family/community relationships to promote positive mathematics learning and achievement" (National Council of Supervisors of Mathematics and TODOS, 2016). In this paper, I present findings based on a semester-long project with preservice teachers (PSTs) focused on the Flint water crisis. I begin this paper with an overview of research on teaching mathematics for social justice. Next, I describe the context of the study, the participants, and articulate key elements of the data sources. I then provide excerpts from transcript data that illuminate how PSTs negotiated the complexities of planning mathematics lessons focused on social justice. After identifying themes that emerged in the data, I conclude by discussing the implications of the findings.

Background

While teaching mathematics for social justice is not a new concept in mathematics education, understanding how preservice teachers come to enact this pedagogy is still relatively new to the field. Previous work around this topic has examined PSTs beliefs about teaching injustices or controversial issues (Simic-Miller, Fernandes, & Felton-Koestler, 2015). Gonzalez (2012) articulates four components of TMfSJ. These components include students having access to rigorous mathematics, that mathematics is re-centered on issues related to historically marginalized students, that mathematics is used to critique society, and that we use the knowledge generated from the previous three constructs to advocate for change (Gonzalez, 2012). For PSTs to engage in this type of pedagogy, Felton-Koestler (2017) states that PSTs must experience mathematics for social justice as a learner, see examples of what this could look like in practice, and reflect on their own beliefs about mathematics. Much of the extant literature around TMfSJ calls attention to the fact that PSTs need explicit exposure to examples of these lessons and

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opportunities to plan lessons for themselves as they will not likely find social justice lessons in their school curriculum (Leonard & Evans, 2012).

Bartell (2013) described secondary teachers' attempts to teach mathematics for social justice. In this study, in-service teachers enrolled in a graduate course designed, implemented, and revised a mathematics lesson that had social justice goals (Bartell, 2013, p. 136). Findings from this study indicated that teachers had varying definitions of what it meant to teach mathematics for social justice ranging from awareness, to cultural exposure, to student empowerment. Another finding from this study was that participants felt tensions between "mathematical goals and social justice goals" while planning (Bartell, 2013, p. 141). I have replicated these findings in my work in that many of the topics elementary PSTs selected when planning a social justice lesson related to their own goals for the lesson (e.g., wanting to expose their students to world issues) as opposed to addressing students' needs (Myers, 2017). PSTs also planned lessons that focused on current events or chose less critical topics (e.g., discussing pet adoption instead of racial issues involved in the adoption of children) because of their belief that young students could not handle this type of mathematics, for example (Myers, 2017).

While previous research has demonstrated that PSTs can design lessons focused on social justice topics, it is unclear how they negotiate the tension between mathematical goals and social justice goals in their lesson planning activities. Further, much of this work has focused on analyzing survey data about PSTs beliefs or examining completed lesson/unit plans (Leonard & Evans, 2012). This study makes a unique contribution to the field in that the focus is on exploring the conversations that PSTs engaged in while planning social justice lessons. After a discussion of the theoretical framework and methods, I will share themes that emerged from the analysis along with sample text from transcripts of the PSTs lesson planning sessions.

Theoretical Framework

This study is grounded in Gutstein's (2003 and 2006) framework for teaching mathematics for social justice. The goal was for PSTs to unpack the Flint water crisis and think about how mathematics could be used as a tool for elementary students to engage with and act upon this injustice. In essences, how could we use mathematics to *read* the Flint Water Crisis? Gutstein (2003) defines *reading the world with mathematics* to mean:

> [Using] mathematics to understand relations of power, resource inequities, and disparate opportunities between different social groups and to understand explicit discrimination based on race, class, gender, language, and other differences. Further, it means to dissect and deconstruct media and other forms of representation and to use mathematics to examine these various phenomena both in one's immediate life and in the broader social world and to identify relationships and make connections between them. (p. 45)

To help students engage in *reading* the Flint water crisis, I provided PSTs with articles, links, and hashtags to read and follow before our discussion. I intentionally selected multiple forms of media (e.g., print media, blogs, social media) as well as publications from different political backgrounds (e.g., CNN, Fox News, and The Root) so that PSTs could see this crisis from multiple lenses and begin to think about how to negotiate various viewpoints.

Another essential framework for this study was the Culturally Responsive Mathematics Teaching (CRMT) Lesson Analysis Tool. This tool was developed as a part of the TEACH-MATH project and was intended to support teachers in critical analysis of how they plan and implement

lessons (Drake et al., 2015). Because previous literature highlights challenges PSTs face with maintaining the mathematical goals of the lesson, it was critical to select a framework that explicitly draws the user's attention to mathematical goals of a lesson as well as sociopolitical goals. Additionally, one "critique" of TMfSJ is there "where is the math" question. This framework contains elements of "good mathematics teaching" (e.g., open tasks and discourse) as well as critical components of reading the world with mathematics. This tool is composed of six categories including cognitive demand, depth of knowledge and student understanding, mathematical discourse, power and participation, academic language support for ELLs, and cultural/community-based funds of knowledge (Drake et al., 2015). Each of the six categories is further delineated by a five-point rubric where level one articulates a less sophisticated or appropriate approach to the category and level five represents an ideal demonstration of the construct.

Methods

Context

I conducted this study in a semester-long mathematics methods course. Students were simultaneously enrolled in literacy, science, and social studies methods courses and followed a cohort model. In addition to taking four methods courses, all students completed a 200-hour field requirement during the semester where they were expected to progress from completing structured observations, to one-on-one interviews, to small group activities, and ultimately teach a whole-class lesson.

As the PSTs worked on this lesson planning activity, they had a variety of resources to use while planning. They had electronic access to the state standards, the departmental lesson plan template, documents that listed mathematical supports and scaffolds for ELL students, as well as articles about the Flint water crisis. One graphic that the students were particularly drawn to is shown below:

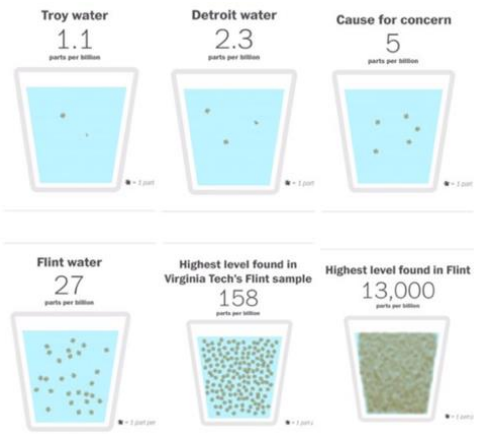

Figure 1: Michigan Water Level Contaminations. Reprinted from "We had to make some cuts": Flint water catastrophe a matter of business, by D. Johnson, Retrieved from http://www.occupy.com/article/we-had-make-some-cuts-flint-water-catastrophe-matter-business#sthash.o2xFPb6m.dpbs. Copyright 2016.

Participants

Seventeen PSTs participated in this study. Of these participants, five identified as African-American, seven identified as White, one as Hawaiian, two identified as Hispanic, one as

Jamaican, and the final student identified as Vietnamese. Three of the PSTs students were bilingual (they learned English as a second language) and all of the students identified as female. The racial makeup of this class was atypical in comparison to other sections of the course offered that semester and the overall demographics of the department.

The students worked in grade-level teams according to the grade level they were placed in for their field experience. There were five groups in the class. Three groups of PSTs worked on first-grade lesson plans, one group worked on a second-grade lesson plan, and the final group worked on a third-grade lesson. In this paper, I will share the results of one subgroup of this study that was made up of three PSTs. Two of the three PSTs in this subgroup identified as White. The third identified as African-American.

Data Sources and Analysis

Data sources for this study included small group lesson plans and audio recordings of lesson planning sessions. The lesson plan template asked candidates to: identify a GA standard; state the problem to be solved (based on the Flint water crisis); identify tools needed; identify polysemous words, cognates, and other vocabulary demands; pose probing questions to ask students; articulate differentiation strategies; as well as create summative and formative assessments. I used this lesson plan template because it is a required template for the department. In the first part of this project, candidates were given three hours in class to work on their group lesson plans.

Both ongoing and retrospective data analysis were used. Data were coded using open coding (Merriam, 2009). After broad themes were identified, I looked for examples of each of the six categories from the CRMT lesson planning tool. Although the tool can be used to "rate" each category of the lesson plan, I will not provide ratings as the focus of this study is to explore the complexities of PSTs conversations as opposed to the final result of what was produced on the lesson plan.

Findings

For this paper, I am going to discuss the data from one of the first-grade groups. A few themes emerged in the analysis. In the subsequent sections, I will discuss each of these themes in greater detail and offer examples from the transcripts and lesson plans to illuminate the case.

Standards vs. Tasks

At the start of the semester, I engaged the class in a discussion around the elementary mathematics standards for the state. We also engaged in a discussion about some of the way's standards are used, and expectations school administrators typically have for how teachers implement standards-based instruction. This is a critical conversation to have with PSTs because in my previous work, I have found that there is significant push back given that mentor teachers believe that TMfSJ falls outside of the standards. Therefore, helping PSTs understand that this potential pushback is coming can help them be proactive about justifying their lessons and the resulting tasks. Additionally, negotiating standards and TMfSJ is an integral part of the political work of mathematics teaching.

As the PSTs continued reviewing the state standards, they would select multiple standards to work with. They would then develop a task aligned with that standard. This process was not linear however, and it appeared that PSTs vacillated between choosing a standard and developing a task. There were a few examples of this in the data:

Student C: So, I guess they could count the number of things in the cup [see Figure 1 above] and then write it out. Could we maybe have them count to understand place value? Like maybe ten particles in a cup equals the Flint water.
Student A: I see where you're trying to go there
Student B: You're trying to use place value
Student A: I'm trying to put that into words
Student C: Have them think of like…
Student A: Have them use the particles like blocks…like base-10 blocks
Student C: Yes…have them understand that…
Student A: I don't know how we would convert all that though
Student B: You would convert it just like you would anything else. You would have one particle [referring to the particles in the cups pictured above]…Instead of trying to like come up with or find something that fits in more complex ones, we can work with what we have. Because we know we can do households affected…like with number of people. Cause you can find that easily…you count…you know what I mean?
Student A: So, should we do word problems?
Student B: Yeah…work with what you can do…no trying to re-invent the wheel.
Student A: Right…so that would be like use addition and subtraction within 20 to solve word problems that involve situations of adding to, taking from, putting together, taking apart, and comparing with unknown

When this clip begins, the PSTs had planned to create a task based on representing and interpreting data. After the PSTs had some difficulty translating this into a task, one of the group members suggested a standard that focused on place value. From there, the PSTs begin to discuss how they could get students to count and graph the particles of water in Figure 1. Another student then suggested that the conversions (particularly the two cups that are represented with decimal numbers) will be too difficult and that the task should include discrete values only. This data highlights that PSTs were trying to coordinate the standard they selected, a possible task, and the cognitive demand of the proposed task. The conversation then shifted to creating a word problem, which is a different standard. This pushed one of the PSTs to now select a standard that addresses solving word problems within 20.

PSTs looked at other research they had done on Flint, and this conversation continued until they settled on a standard and a task:

Student A: I think I would go with the one that has addition and subtraction so that we could do like…you know…x amount of homes had this many or this many homes got infected, how many homes were left uninfected?
Student B: Say that again…
Student A: If you started with the number of homes that were uninfected and then gave them the number of homes that got infected, how many homes were left uninfected
Student B: So, you could say there were this many homes in Flint…50 homes in Flint…20 of them got affected with lead poising due to unclean water. How many more homes have yet to be affected? Thirty. Ok …let's go with that.

Standards as Keywords

Like the previous example highlights, unpacking standards is a complicated task. Initially, some PSTs assumed that they would teach one standard per day until all grade-level standards had been exhausted. As students entered methods courses and started field placements, they were exposed to how standards must be unpacked and that each standard is comprised of smaller learning goals. As PSTs attempted to unpack the standards in this study, they pulled keywords from the standards and tried to map keywords from the standard onto elements of the social justice context. In the following example, you will see that the words *represent* and *interpret* were selected to frame a possible task for students.

> Student A: Let's use organize, represent, and interpret data up to three categories
> Student B: Represent…you can compare the lead in the water to the amount of people that ended up sick…that can be *represented* on a chart…data…at this rate…you can use one city [referring to Figure 1 above]…you can like *interpret* the data…like if they keep on using this water source and you look at the ratio between the people getting sick and how in a year or two years how much more people would end up getting sick.

Data seemed like a natural first step for PSTs to consider when planning this lesson. One PST continued looking at the standards as the rest of the group was working and noticed that, "It looks like represent and interpret data is under every standard though." The PSTs decided that this standard was too broad and that they should look for something more specific than *representing* and *interpreting*.

Planned Supports vs. Standards vs. The Task

It seemed that the PSTs had settled on a standard and created a word problem that aligned with that standard. The discussion then shifted to what types of tools they would use to support students in developing rich mathematics. Much of their conversation here centered on category two of the CRMT Lesson Planning tool in that the PSTs grappled with what they could provide students with so that students could show their learning. The challenge that emerged here is that as the PSTs tried to engage in this discussion, they found that their planned supports were not necessarily aligned to the standard they selected or the word problem they created.

> Student A: Ok…so what tools will we use?
> Student B: Modeling? It has one for model with mathematics and it has use appropriate tools.
> Student A: Under tools?
> Student B: But I'm thinking tools can be rulers, graph paper…
> Student A: I want to say like…manipulatives…because yeah, those dots…I think they're just called counters
> Student B: So, is graph paper not a tool?
> Student A: So, are we going to have them create graphs? Because that is not part of the standard.
> Student B: I thought you was comparin' …it could be.
> Student A: I feel like you would show them the graph to say 'hey this is what's happening here and this is what's happening here'
> Student C: What exactly are we doing?

Student B: The water pollution vs. the people getting sick. Basically, the water pollution vs. the people going to the hospital. I guess I don't know how you'd compare that in one city. That would be hard the hard thing. Ehhhh…I don't know.
Student A: Uhhh…not yet. Well we have the math part…so maybe we can at least… I'm confused
Student B: What are we doing? Let's start with that
Student A: They're gonna do word problems. So, they're not…
Student B: But you can show word problems though…you know what I'm saying?
Student A: So, they can draw it out and use graph paper…so I can definitely see it to be used there. I put down manipulatives and by manipulatives I put i.e. counters. I put down graph paper.
Student B: What did you put next to the manipulatives? You could use white boards? I'm thinking too much into it.

As you see here, the conversation about manipulatives caused the PSTs to question the standard they had selected as well as the goals of the task. To help reconcile this difficulty, the PSTs engaged in a discussion about what mathematical tools were, what tools were necessary for students to solve a story problem, and additional layers about the Flint Water Crisis. As I stated earlier in this analysis, planning lessons related to data seemed like a "safe space" for PSTs to develop tasks. The notion of comparing and representing data re-emerged in this discussion, although it was not related to the word problem the PSTs previously decided on.

Is the Context Fixed?

Recall that a component of teaching mathematics for social justice is that mathematics be used to examine a socio-political context. Moreover, this examination is not solely to better understand the setting but also to create an avenue for advocacy. A key learning that emerged from this study is that although we spent a significant amount of time unpacking the water crisis, once PSTs started planning the lesson, Flint went from being a dynamic sociopolitical context to a fixed context. This was further confounded as PSTs went back and forth about the type of task they wanted to create. At one point, they planned to use existing data to graph. Later in the discussion, they considered the idea that this problem may not be fixed and they wanted to project the type of damage that could occur if the necessary changes to infrastructure did not happen. The PSTs then settled on creating a word problem that used Flint as a context (e.g., infected homes versus homes that are not infected).

As they continued working on the lesson plan, further dialogue emerged around the mathematical goals and the social justice goals for the lesson. The exchange below provides additional insight into this:

Student A: So, one goal should be make sense of problems and persevere in solving them?
Student B: Where are you finding this?
Student A: I am on the GA standards website. I think another goal should be for them to understand the severity of the water crisis since that's what we're…
Student B: But you can't say understand…umm…I remember one teacher saying that when you set goals for students you can't say things like they're going to understand…You can say make them aware
Student C: So, make the students aware of the severity of the water crisis

These examples illuminate different conceptions of a social justice context. For instance, if PSTs treat the context as something static (e.g., a word problem to be solved or fixed data points to graph), the actual goals of TMfSJ may never be realized because no action emerges from these types of tasks. The discussions that we engaged in when unpacking Flint as a class did not carry into the lesson planning discussions. As this last set of data from the transcript reveals, PSTs sought to raise awareness about Flint without an additional step of advocacy or effecting change.

Implications

This study adds to the extant literature in the field by providing details about the types of challenges PSTs negotiate while planning lessons focused on TMfSJ. Although scholars typically analyze completed lesson plans, studying the lesson plan along with the dialogue from the transcripts, provides us with new insights. First, given the complexity of TMfSJ, PSTs can benefit from sustained opportunities to engage in some of these categories independently (e.g., unpacking standards and socio-political contexts) before attempting to create a full lesson plan. For example, if PSTs do not know how to fully deconstruct a socio-political context and see the historical underpinnings of it, Flint and other social injustices will be reduced to a simple context for a problem just like shopping in a store or playing video games. As presented, the PSTs discussions in this portion of the study aligned with level three of category 6b in the CRMT-TM Lesson Analysis Tool. This highlights that while PSTs did plan for opportunities to analyze a socio-political context, they did not intend for students to engage in discussions about how the mathematics could be used to change or transform the problem (levels four and five of category 6b).

Categories one and two of the CRM-TM Lesson Analysis Tool address the cognitive demand in the lesson as well as the opportunities to develop students' depth of knowledge. During this study, it was clear that PSTs own content knowledge directly impacted their ability to plan lessons aligned with level five in each of these categories. For example, the word problem that this group settled on did not provide opportunities for "complex mathematical thinking, [utilizing] multiple representations…or complex understanding" (TEACH-MATH, 2012). Therefore, PSTs need ongoing development of their mathematics understanding as they plan lessons. As I highlighted above, PSTs abandoned one potential task because they did not think they could do the necessary numerical conversions.

Another overall finding from this work is the balance between learning to develop such a complex skill compared to PSTs trying to meet doing a “good job” with this activity (although it was not graded). PSTs were very concerned about demonstrating everything that was required for the assignment and wanted to be sure they were getting it right. PSTs seemed to think that there was one “preferred task” that they should pick to work towards developing a standard. Therefore, there were many times during the conversation that the PSTs wanted to quickly decide on what to fill in for the lesson plan template to satisfy the professor. Mathematics teacher educators must be explicit that the purpose of these assignments is for PSTs to navigate this complex process in a safe space free from assessment.

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